AC-LGAD sensor Beta source measurements

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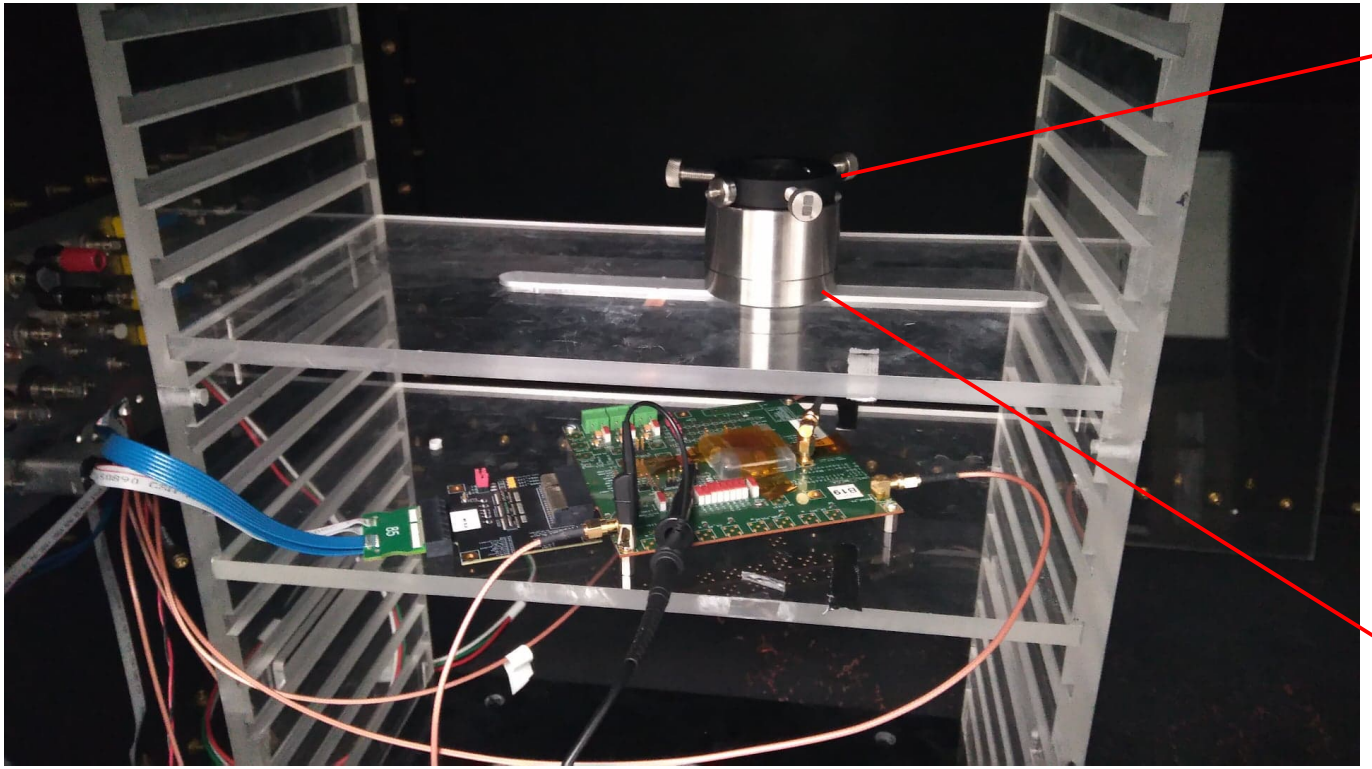
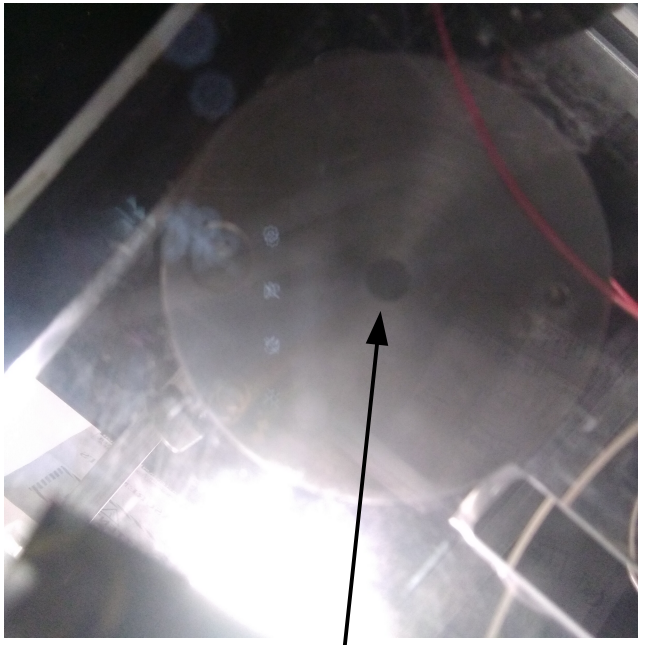
Experimental setup





Beam hole for Sr-90 [37MBq]

Motivation: quantify the sharing with the real signal.

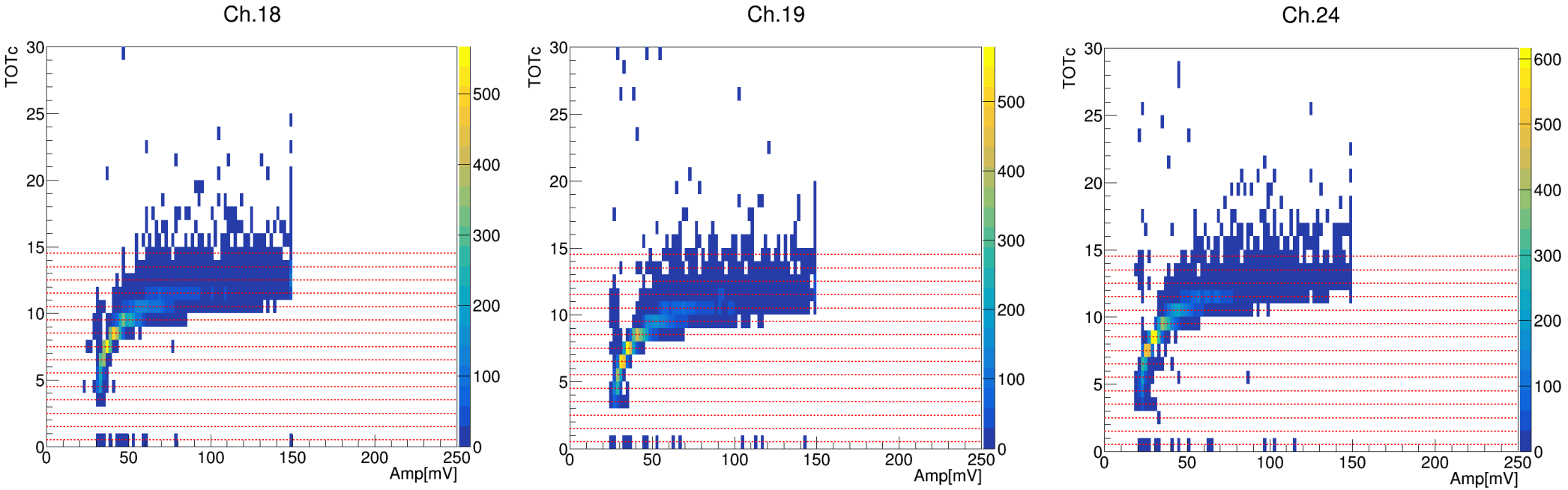
The Setup:

- ASIC and source are placed inside the Dark box.
- The Beta source is placed right above sensor, 5~10 cm away.
- High Voltage on sensor is -170V

Data - TOT and scope

signal(injected charge from test board)

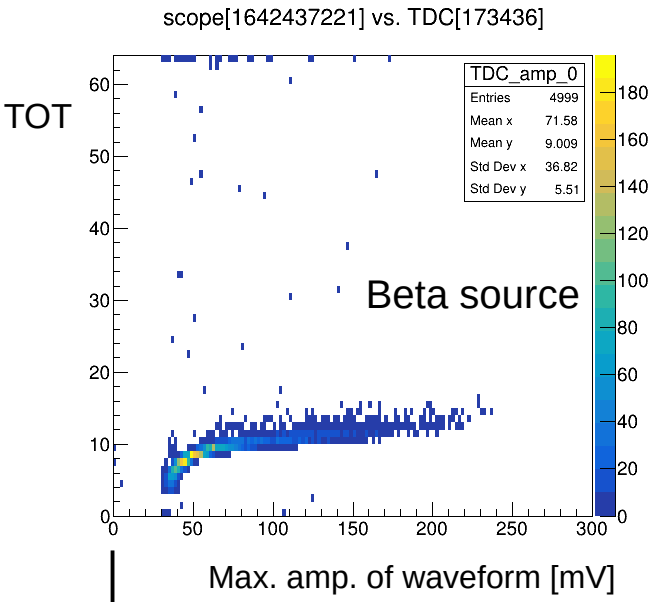
- HV = -170V
- #events: 10000(beta source)
- The baseline is different from each channel, corrected the threshold with slow control
- TOT can't work well due to the distortion, needed to be corrected by signal amplitude.



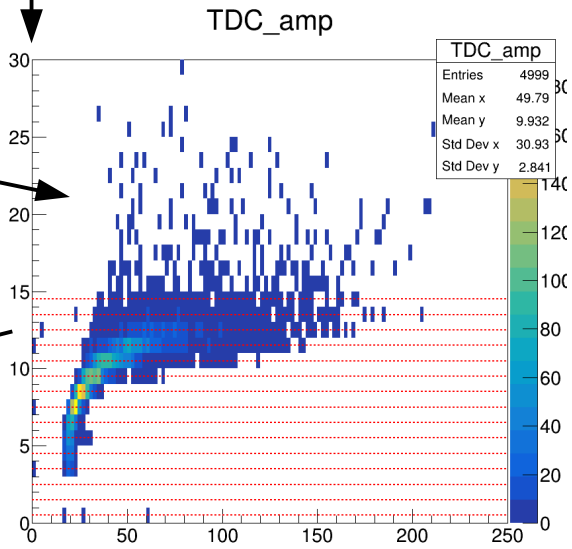
For TOT, take the average of the amplitude

Data - TOT and scope

- Since the signal distorted after passing the discriminator, we are not able to get correct TOT value.
- Correct TOT with the amplitude of waveform
  - TDC: the decode TOT value, ranged from 1~64 DAC unit
  - Scope: 1000 sampling points of waveform, find the Max. amplitude of the waveform
  - $TOT_i = Amp_j \times N_j / \Sigma N_j$



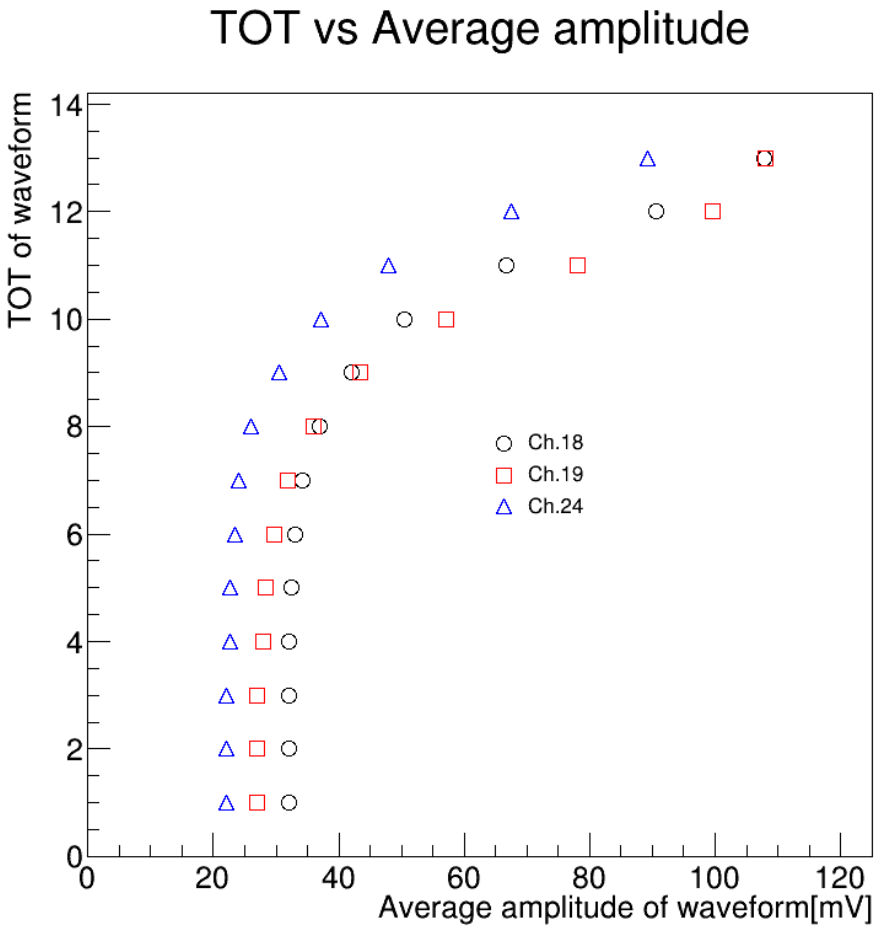
Zoom in

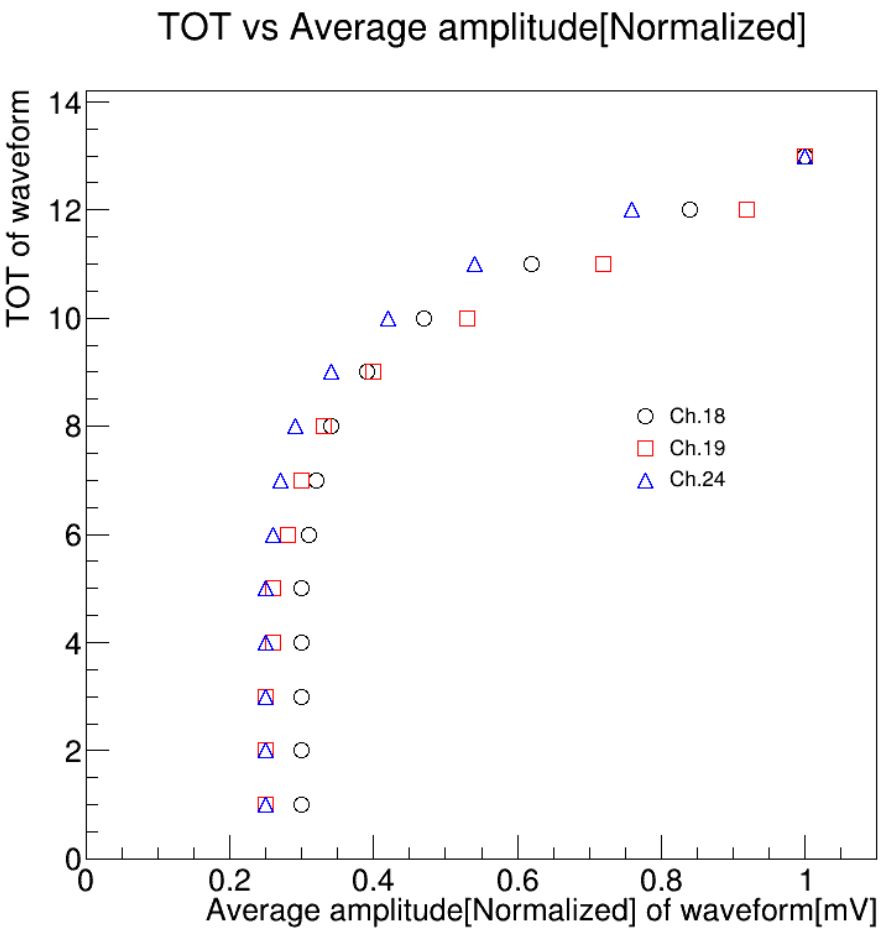


	Average Amp[mV]			Average Amp[Normalized]		
TOT	Ch.18	Ch.19	Ch.24	Ch.18	Ch.19	Ch.24
1.00	32.00	27.00	22.00	0.30	0.25	0.25
2.00	32.00	27.00	22.00	0.30	0.25	0.25
3.00	32.00	27.00	22.00	0.30	0.25	0.25
4.00	32.09	27.99	22.61	0.30	0.26	0.25
5.00	32.47	28.42	22.64	0.30	0.26	0.25
6.00	33.04	29.73	23.48	0.31	0.28	0.26
7.00	34.14	31.93	23.96	0.32	0.30	0.27
8.00	36.89	36.00	26.08	0.34	0.33	0.29
9.00	42.12	43.41	30.48	0.39	0.40	0.34
10.00	50.45	57.05	37.21	0.47	0.53	0.42
11.00	66.66	77.99	47.91	0.62	0.72	0.54
12.00	90.52	99.59	67.44	0.84	0.92	0.76
13.00	107.83	108.06	89.27	1.00	1.00	1.00

After normalized with its Max. amplitude

Data - TOT and scope

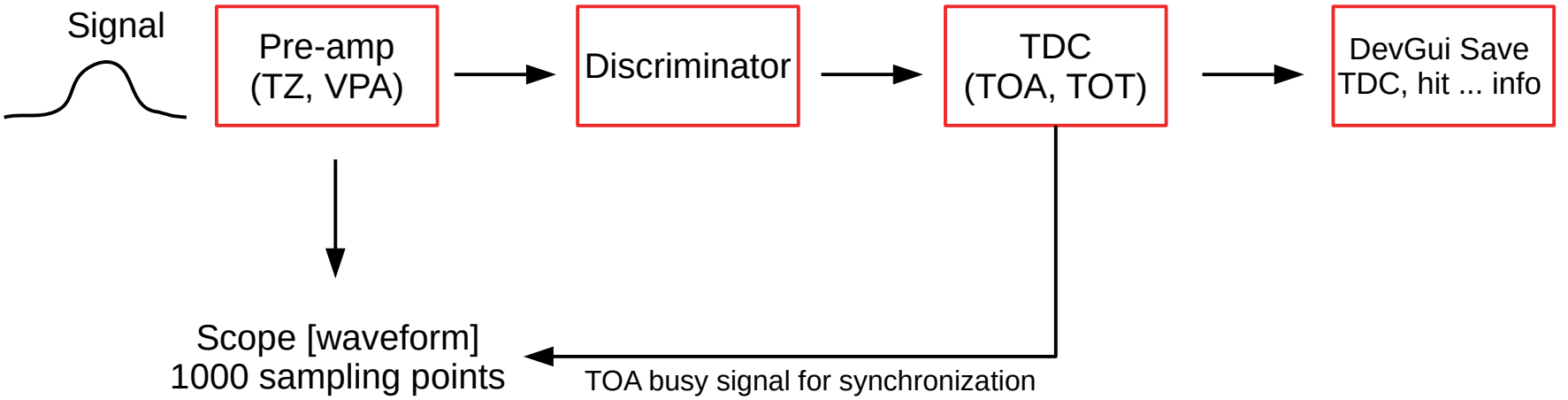




After normalized with its Max. amplitude

The flow chart of data acquisition

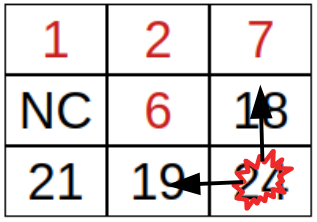
- Only focus on TZ channels
- Using TOA busy signal as the trigger of scope to save the waveform



The sharing between channels

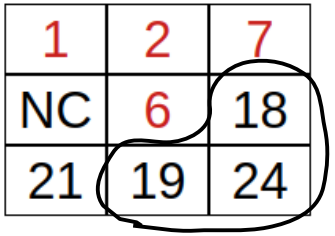
- Setting for 3 TZ channels beta source measurements
  - HV: -170V
  - Channels: 18, 19, 24
  - General Threshold: 390 DAC unit
  - Individual Threshold: 84, 62, 40[need to be checked in the scripts]
  - # events: 105k
- Sharing calculation
  - When ch.[18, 24, 19] => sharing happen
  - Transfer the TOT value of these channels to normalized amp with the table shown in p.4
  - Calculation: $\text{sharing}_{ch} = \text{Normalized Amp}_{ch} / \Sigma\text{Normalized amp}_{ch}$

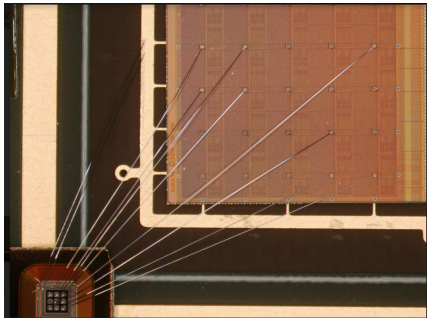
Ex: Ch.18, TOT = 3 -> Normalized Amp = 0.3, **Ch.24 share to Ch.18 = 0.3 / (0.3 + 0.26 + 0.54) = 27.3%**
Ch.19, TOT = 4 -> Normalized Amp = 0.26, **Ch.24 share to Ch.19 = 0.26 / (0.3 + 0.26 + 0.54) = 23.6%**
Ch.24, TOT = 11 -> Normalized Amp = 0.54,



24 share to 18 and 19
$TOT_{24} > TOT_{18}$ and $TOT_{24} > TOT_{19}$

Sensor to channel map

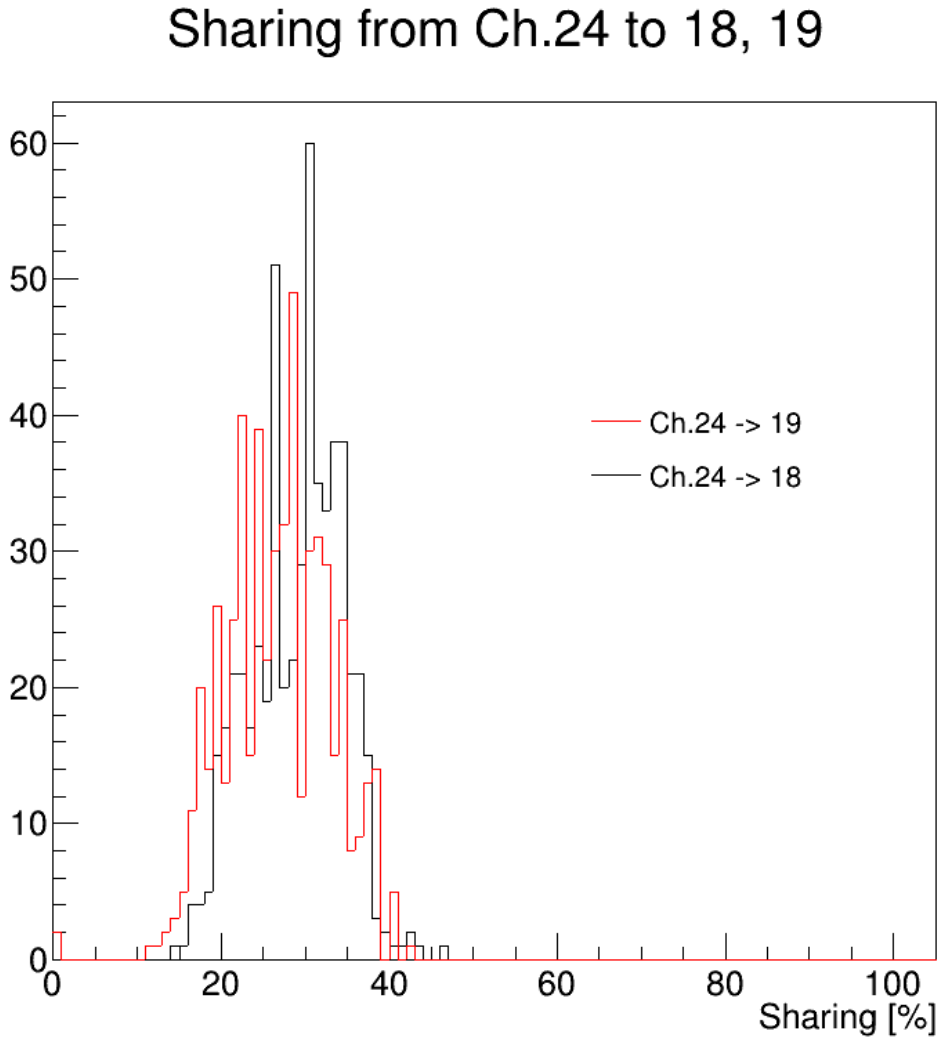




Sharing from Beta source

1	2	7
NC	6	18
21	19	24

24 share to 18 and 19
$TOT_{24} > TOT_{18}$ and $TOT_{24} > TOT_{19}$



Sharing from inject charge

- HV of the board: -170V
- inject 8pF, 40pF @ ch.24, ch.02 respectively
- The sharing is calculated from its own maximum amplitude at 8pF, 40pF respectively

Sensor to chip ID map

1	2	7
NC	6	18
21	19	24

	Mapping of the channel			Inject charge 50DAC-bit [40pF]			Inject charge 10DAC-bit [8pF]		
Sharing of TZ channel (injected Ch.24)			18		13.2%			18.9%	
		19	24	4.0%	100.0%		10.0%	100.0%	
Sharing of VPA channel (injected Ch.02)	1	2	7	26.4%	100.0%	23.4%	22.4%	100.0%	23.1%
		6			21.7%			13.0%	

Sensor to chip ID map

1	2	7
NC	6	18
21	19	24

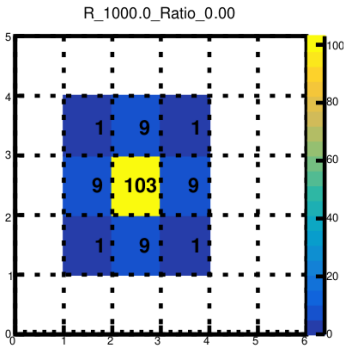
Conclusion & Next Step

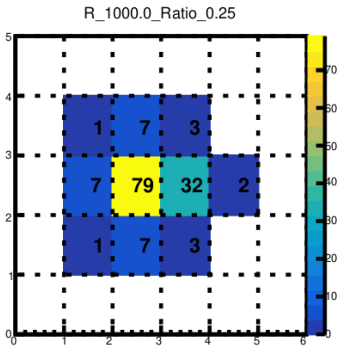
- The sharing measurement is limited by the number of readout of the waveform, will be solved in next version.
- From the beta source, we can get the sharing from 30 ~ 40%, which is higher than the sharing result from injected charge, ~15%.

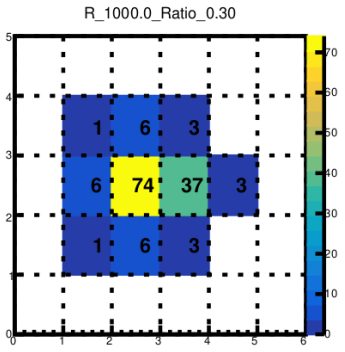
- Measuring the sharing as function of inject charge and position, which can not be done by beta source, we start to setup the laser test bench for the further measurements.

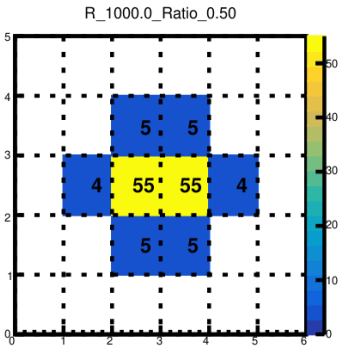
Backup

Backup





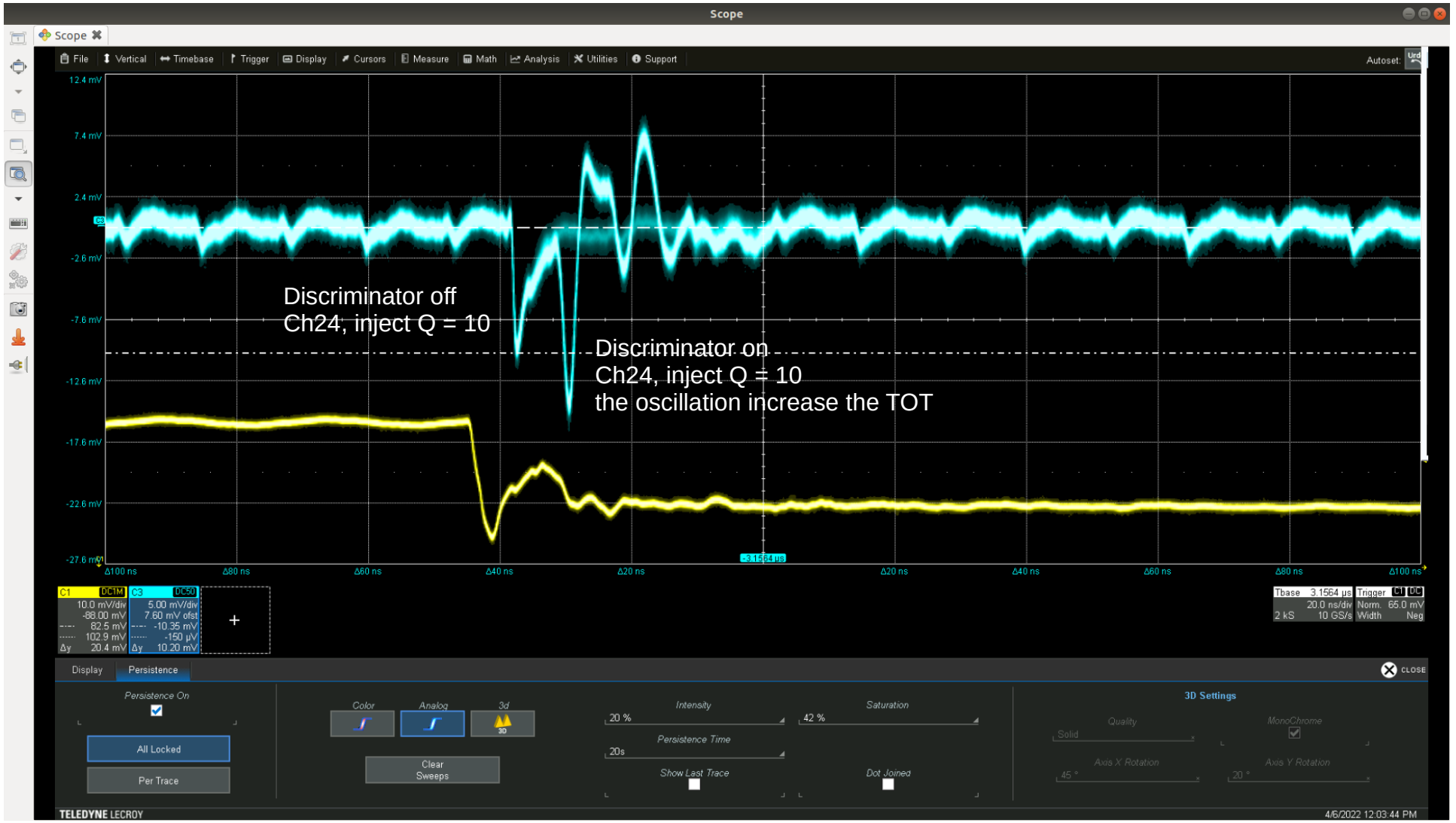




Simulation TZ, inject charge: 19pF

Backup

Backup


Scope
Discriminator off
Ch24, inject Q = 10
Discriminator on
Ch24, inject Q = 10
the oscillation increase the TOT
TELEDYNE LECROY